Original Articles.

THE ANATOMICAL APPEARANCES RESULTING FROM POISONING BY ARSENIC.¹

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THE notes presented in this brief paper relate solely to that class of cases of arsenical poisoning which may be properly designated as acute—cases, in other words, in which death follows a single toxic dose of arsenious acid after an interval of time not exceeding forty-eight hours. The anatomical appearances here described will be, in the main, such as the writer has himself observed in his inspection of the dead bodies of persons who have killed themselves with arsenic. In these observations, the toxic effects of this poison have seemed to take a wider range and a more comprehensive character than the standard text-books of toxicology would lead one to believe. The writers with whom students of forensic medicine are most familiar, such as Taylor, Guy, Casper and Reese, give the distinct impression that arsenical poisoning is essentially an affair of the stomach and intestines, and that other organs and regions have either no interest at all, or an interest so remote as to be hardly worth mentioning. The appearances which the gastric and intestinal mucous membrane presents are generally described with great particularity of detail; and the color-effects, the red evidence of "irritation," are especially elaborated to impress the memory; for to nearly all authors of toxicological works, arsenic is a typical "irritant" poison, and, being such, its characteristic effect should be inflammatory redness. Moreover, it is fair to state that toxicologists are usually distinguished as chemists, not so much specially interested in the anatomical appearances of organs as in the best methods of recovering the largest amount of poison from those organs; if they see anatomical specimens from the victims of arsenic, it is not usually at the autopsy-table, but after an interval of hours or days, when the organs are submitted to them in the chemical laboratory, and after exposure to air and the conditions favoring decomposition have materially modified the original appearances. It is for these reasons that the descriptions which are given in the standard text-books on poisons, so far as they relate to the post-mortem appearances left by arsenic, are incomplete and unsatisfactory. I shall be pardoned, therefore, if in addition to the mention of certain anatomical features of arsenical poisoning, well-known because oftenest found in the books, I include other features less familiar, but scarcely less interesting or important, which I have personally noted.

Let us suppose, now, that the dead body of a man is found. He has taken a quantity of arsenious acid in secret with suicidal purpose, and has carefully destroyed all the evidences of his act and intent. He has died without antidotal treatment, and his dead body affords the only present available proof of the cause and manner of the death. What are the indications which the medical examiner finds at the autopsy to suggest to him that arsenic was the lethal agent, and to guide him as to the propriety of chemical confirmation of his post-mortem diagnosis?

It is not to be understood that these data for diag-

nosis are uniform in kind or in degree in all cases; in this respect, arsenical poisoning is not different from most pathological processes. The changes which result from the ingestion of a fatal dose of arsenic are subject to manifold modifications. The state of the stomach in its relation to the last meal of food, the amount of its fluid contents, and other conditions interfering with the direct disposal of the poison, will at once occur to the mind as factors to control the post-mortem appearances. Time, too, is an important element in the matter; the interval between the ingestion of the poison and the death of the patient, and the interval between the death and the autopsy, ought to be considered in this connection. But perhaps the most striking modification, and one that is not sufficiently noted in descriptions of the stomach and intestines after arsenical poisoning, is that due to the treatment which the patient receives. Much of the so-called "inflammation" in these cases is caused, without doubt, by the arsenic; but not a little of the redness of the mucous membrane is more readily traceable to the mustard and other emetics, to the iron and other antidotes, to the irrigation and other measures designed and applied with proper vigor and assiduity for the relief of the patient. Of the arsenical stomachs which I have seen, that one best fulfilled the description of the text-books which had received during the life of its owner copious doses of hydrated sesquioxide of iron urged upon her as long as she could swallow during the nine hours which intervened between her poisoning and her death.

Avoiding in our review of the post-mortem appearances referable to arsenic this and other sources of error as far as we can, let us study the anatomical changes which an uncomplicated case of acute poisoning would probably present.

Externally, the body would present but few indications of the cause and manner of the death. The facial expression usually suggests suffering in the last moments of life, in harmony with the characteristic clinical course of events. The degree of post-mortem rigidity is marked. If the subject is plethoric, widely extended patches of livid discoloration occupy the dependent parts of the body; sometimes, the dull bluish color of these lividities is replaced, in part, by a rosy red, a change particularly noticeable if the autopsy is delayed. The skin frequently shows another change from its normal post-mortem color or pallor, and this consists in a sallow or yellowish hue, suggesting icterus. I have observed in some instances a narrow line of ecchymosis upon the prolabial mucous membrane, that of the lower lip especially, to be explained probably as an incident of the clinical history of the poisoning, as it was most marked in cases in which vomiting was a marked symptom. Exceptionally, the tongue is seen to be reddened, but otherwise the cavity of the mouth and pharynx presents nothing remarkable.

Turning now to the internal parts of the body, let our examination take the usual course, as if we had no clue to the cause of the death and our inquiry of the several organs was to determine that clue and establish the diagnosis. Orth says:² "In medico-legal cases, in which a well-founded suspicion may be formed as to the cause of death, the rule is to begin with that cavity in which the suspected changes are to be found." In our present study we assume that we are not in

¹ Read before the Massachusetts Medico-Legal Society, October 3, 1888.

² A Compound Diagnosis in Pathological Anatomy, p. 40.

possession of this "well-founded suspicion," but that we approach our inspection without any bias or preconceived theory.

The brain and its envelopes will give us negative information. Although the brain is said by some chemical authorities to have a special affinity for arsenic, and that hence it has very great value as material for chemical examination, the presence of the poison does not leave any characteristic objective impress upon the organ. Most of the authors on toxicology make no mention of this region in describing the anatomical appearances due to arsenic; if any note at all is made, it is to remark that "congestion" is sometimes observed. In my own cases, the injection of the cerebral and meningeal vessels has been remarked mainly in cases in which morphia was used to allay the toxic symptoms.

The organs of the thoracic cavity next demand our attention. In cases in which death has followed quickly after the ingestion of a fatal dose of arsenic, the heart escapes injury; the color and consistency of its muscular tissue remain normal. But if life be prolonged beyond eight or ten hours, parenchymatous changes are developed, and the normal red color of the ventricular walls becomes changed to pale or yellowish, while the consistency of the muscular tissue is diminished and is friable under pressure, a condition betokening fatty degeneration. Just when this change in the cardiac muscle begins, it is difficult to state with definiteness; it is an early effect of arsenical poisoning and coincides with the absorption of the poison into the blood. It is certainly a rapid change and must be one of the factors in the cause of death. I have seen it in a case in which death followed after an interval of six hours; and, on the other hand, it was not manifest in the heart of a young woman who survived ten hours.

Another appearance in the heart, and one that I have been disposed to consider as characteristic of arsenical poisoning, is the presence under the endocardium of the left ventricle of ecchymoses, not larger than a dime and usually limited to the posterior wall or the interventricular septum. These ecchymoses are generally single, and they rarely exceed two in number. In depth they are superficial, section displaying simply a thin layer of blood under the endocardium. In one instance I have seen ecchymoses on the external surface of the heart under the visceral pericardium; they were about the size of a split pea, and were found mostly on the upper part of the left auricle between the aorta and the appendix auricular.

The blood in most cases is dark in color and fluid in consistency, whether it be observed in the right ventricle or in the large arteries. It is described as "syrupeous" by some writers, but my cases have not yielded a result that could be designated by that term, unless the syrup were understood to be very thin.

Writers on poisons have not found anything noteworthy to state concerning the lungs, with reference to their appearance after death by arsenic. Yet there are one or two features growing out of the condition of the blood that seem deserving of mention. The fluid state of the blood permits its ready gravitation to the dependent portions; hence we generally find an unusual degree of hypostatic blood-supply. In some cases, the blood takes on color-changes which show best in the lungs; the anterior and upper portions are of a florid, almost vermilion hue; while the posterior

and inferior parts retain their dark purple. The appearance of the lungs in these instances is not unlike the effect produced by carbonic-oxide poisoning. Another phenomenon referable to the blood is the presence of capillary hæmorrhages under the visceral pleura; these are few in number, varying in size from that of a mere point to that of a grape-seed, and they are usually limited to the lower parts of the lung and to the fissures.

Turning now to the abdominal group of organs, and following in our description the usual order, we note, in the first place, that the vessels of the peritoneum, in our hypothetical case of arsenical poisoning, are almost invariably injected to a marked degree.

The spleen gives us nothing of value in our search for data; so far as our present inquiry is concerned, it is of no service to us.

The kidneys present an interesting degenerative alteration, which has received less attention than it has deserved. In proportion to the length of time which has elapsed between the ingestion of the arsenic and the fatal result, these organs will be found to display, in greater or less degree, the evidences of parenchymatous change, due probably to the irritant action of the poison circulating in the blood and seeking an avenue for elimination. At first this change manifests itself in the form of "cloudy swelling," so-called, in which the kidney loses its normal grayish-red color and its firmness, becoming pale and soft and increasing somewhat in size. These changes progress till true fatty degeneration takes the place of the granular degeneration of the earlier stages, and the organ is yellowish gray, flaccid and enlarged. Its section shows a somewhat thickened cortex, yellowish gray in color, with marked opacity, and presenting yellow streaks and spots indicating fatty degeneration of the tubules. The contrast between this portion of the organ and the appearance of the medullary pyramids is distinct because the vessels of the latter are relatively full. Upon microscopic examination, the granular epithelium of the tubules shows an increase in its granular elements, with indistinctness of their nuclei.

These changes begin and go forward with remarkable rapidity, coinciding in this respect with the analogous degeneration of the muscular tissue of the heart. All conditions which favor the ready absorption of the arsenic promote the parenchymatous changes which have been described. In the case of a girl of sixteen, who took a box-full of "Rough on Rats" in water on an empty stomach, and died eighteen hours later, I found the kidneys presenting the characteristic appearances of the earlier stage of fatty degeneration. On the other hand, these appearances were absent from the kidneys of a young woman who died nine hours after swallowing half a box-full of the same handy preparation of arsenious acid.

The pelvic viscera yield no data that are of service in the post-mortem diagnosis of arsenical poisoning. Sometimes the bladder displays in its lining membrane some dull red spots, but these are neither constant nor characteristic.

The appearances presented by the œsophagus are of interest because the mucous membrane of this tube comes into intimate contact with the poison on its way to the stomach, and might well be expected to give local evidence accordingly. As a matter of fact, however, this canal is generally of normal appearance.

Rarely, there are patches or long narrow streaks of dull redness. In one case, in which the body of a woman was exhumed for examination ten days after her death, I observed some bright yellow deposits on the mucous membrane of the gullet, the result of the action of the sulphuretted hydrogen of decomposition upon the arsenious acid.

The stomach is the one organ which before all others possesses in the eyes of most medico-legal observers a paramount importance. It receives the poison immediately upon its ingestion, offers its extensive expanse of mucous membrane to the local action of the irritant, engages actively both in assimilating and in rejecting the unwelcome guest and takes in, as well, a variety of agents designed to expel or neutralize the toxic material. It is not strange, therefore, that the post-mortem appearances presented by this organ after a fatal dose of arsenic should have challenged the close attention of medico-legal pathologists. These appearances take a wide range in kind and degree. On the one hand, it is not a very rare occurrence to find a stomach which has suffered no damage whatever by receiving a poisonous dose of arsenic; so far as its gross appearances are concerned, it shows a surprising immunity from the effects which are supposed to be typical; and, studied by itself, it would readily be pronounced normal. On the other hand, we find appearances indicating to the fullest degree the irritant action of the poison, general redness, either of a bright scarlet hue or more often of a dull brownish shade, diffused and confluent in extensive patches of submucous ecchymoses or arranged in parallel streaks which on closer examination are found to represent series of minute hemorrhagic dots. Between these two extremes, each of which has but relatively few examples to illustrate it, we find all degrees and varieties. A common observation is to find the mucosa thrown into long folds or rugæ by the contractions of the muscular coat of the stomach, and these rugæ are marked at their summits by dull, brownish-red discolorations, or present numerous transverse red lines arranged so closely together as to give the effect of a continuous longitudinal streak. The part of the stomach mostly involved in the change is the pyloric end, and here the redness indicating submucous extravasation is generally diffused, giving the surface something like the appearance of red velvet. Occasionally, one is fortunate in finding deposited on the mucous membrane unmistakable evidence of the cause of death, in the form of thick, pasty, whitish-gray patches which are firmly adherent; these are surrounded by a line of vivid crimson, and if the pultaceous mass is carefully scraped away, the underlying mucous coat will be found to display a similar intensity of inflammatory redness, but without the erosion characteristic of an ulceration. Examination of the pasty material with a good lens reveals the typical crystals of arsenious acid. Besides this adventitious lodgement of the poison upon the gastric mucosa, one sometimes finds large areas of the surface covered with a layer of thick tenacious mucus, giving a suggestion of diphtheric exudation. There is, moreover, a swelling of the mucous membrane, demonstrated by the obliteration of the normal line of demarkation between the œsophageal mucosa and that of the stomach. The microscope detects in the gastric glands changes which correspond with those already described in connection with the heart and

kidneys; namely, cloudy swelling of the cells lining the glands, followed at a later stage by their fatty degeneration. It is, perhaps, needless to add that the changes in the stomach due to arsenic are confined to the mucous coat, the muscular and serous coats escaping injury.

The contents of the stomach in arsenical poisoning deserve a passing word. Notwithstanding the violent vomiting which forms such a predominant clinical feature in these cases, the stomach is never found empty, but the amount of matter which it retains is often sufficient to excite surprise. Generally the contained matter consists of a pint or more of thin grumous fluid, brownish-red in color and without odor. Sometimes this fluid has a distinctly reddish tinge from the blood which it contains; if it be placed in a glass jar and allowed to stand a few minutes, this blood-stained portion forms a layer at the bottom, and its hæmorrhagic character is more easily demonstrated. An occasional feature in the gastric contents is the presence of white, soft, flocculent masses floating in the fluid.

The intestines present appearances which are analogous to those just described in connection with the stomach, but in general they are less striking; moreover, lesions of the gastric mucosa and those of the intestinal tract do not correspond in degree in the same subject, for it is not unusual to find typical hæmorrhagic gastritis fully developed, with scarcely any alteration of the intestinal coats. Of all parts of the small intestines, the duodenum shows the effects of arsenic most frequently and most satisfactorily; we observe here the same redness of submucous ecchymosis which the lining of the stomach presents. The summits of the mucous folds are especially the seat of the change; and here, too, one sometimes sees small patches of vivid crimson overlaid with a white pasty deposit, marking the lodgement of the arsenic. Other parts of the intestinal mucosa offer no constant lesion; it is most often found reddened in larger or smaller areas somewhat widely distributed. It is an error to fancy that arsenic leaves its irritant traces uniformly, and that in fatal poisoning by that agent there is in the intestinal lining a general diffused inflammatory redness from the pylorus to the cæcum; such wide-spread effects are occasionally seen, but they are the rare exception.

The contents of the small intestines are fluid, and in general resemble thick rice-water, through which are distributed flocculent lumps of soft whitish matter, and sometimes masses of the poison itself in the form of white, pultaceous collections. If the hæmorrhagic lesion of the gastric and duodenal mucosa is very marked, the blood which has escaped in consequence will give a brownish-red hue to the contents of the intestines.

The colon and rectum are almost always found contracted and empty, with a soft, swollen, grayish lining membrane, covered with white stringy mucus. The redness which is observed in the small intestine and the stomach is not continued in the lower bowel except in protracted or chronic cases of poisoning. It has not been my fortune to observe it in any acute case.

Last and largest in the list of organs which we question for evidence of poisoning, is the liver, the special store-house of the lethal agent. The one characteristic change wrought by arsenic consists of fatty metamorphosis, a change analogous to that ob-

served in the heart and kidneys. In gross appearance, we find the liver slightly increased in size, if changed at all, rather firmer in consistency than in the normal state, and displaying externally and on section circumscribed yellow areas; or, if the change has gone forward to an extreme degree, the entire organ presents a uniform light-yellow color having wholly lost its normal reddish-brown. Here, again, as in the heart and kidneys, the change is a rapid one, a few hours sufficing to reduce the organ from its normal state to a condition in which fatty degeneration and fatty infiltration are associated, the former a late stage of parenchymatous (granular) inflammation, the latter an incident thereto.

This review of the anatomical appearances left by arsenic upon the human body leads directly to the question which is of paramount medico-legal importance; namely, Is post-mortem diagnosis of arsenical poisoning an easy matter? That is to say, assuming, as we assumed at the beginning of this paper, that we are in the presence of a dead body of whose clinical history we know nothing, are the revelations of the autopsy sufficiently characteristic and unequivocal to warrant one in concluding readily that the death was by arsenic? The answer is in the affirmative, upon the single condition that the data are studied in their associated relation, and that their collective significance is the evidence which guides the examiner. There is no single organ whose testimony is sufficiently conclusive to control the diagnosis, with the possible exception of the finding of deposits of the poison upon the gastric mucosa, with a marked degree of inflammatory redness beneath and around them; but short of this, the condition of the stomach, however striking its inflammatory character may be, is suggestive only, the various degrees of irritant effects being explainable by numerous causes other than arsenic. But when, in addition to the presence of gastritis, one finds fatty degeneration of the heart, kidneys and liver, a fluid and dark condition of the blood, and sub-endocardial ecchymoses, he may with clear conscience testify in court that he is of the opinion that the death was by arsenic. In this conclusion, he would probably be confirmed by the results of a properly conducted chemical examination of the viscera. Indeed, without the gastric and enteric data, or with only an insignificant and equivocal degree of inflammatory reddening of the mucous membrane of the digestive tract, the concurrence of fatty changes in the heart, kidneys and liver should arouse the examiner's suspicions, and suggest to him the propriety of seeking the chemist's aid to verify his surmises.

In this paper, I have purposely refrained from discussing controverted questions relating to arsenic and its effects on the system, preferring to set forth in as clear and intelligible a manner as possible the anatomical data of acute arsenical poisoning as I have observed them or as they are agreed upon by standard authors, rather than to indulge in the examination of speculative points or to quote the diverse opinions of various writers upon unsettled problems pertaining to the main theme. Certain incidental topics, too, like the influence of arsenic on putrefaction, the technical methods of conducting a medico-legal examination in a case of arsenical poisoning, and the proper way of preserving and transmitting material for chemical examination, have been purposely omitted. If the

simple and uncomplicated sketch here offered shall serve to promote the practical aims of legal medicine as represented in this Society, its design will have been fulfilled.

CEREBRAL SYMPTOMS CONNECTED WITH PHTHISIS.¹

STATISTICAL PART OF THE PAPER.

BY J. B. AYER, M.D.

IN 1863, Dr. Clouston described a form of mental disease characterized by special symptoms, to which he gave the name of "Phthysical insanity." He stated that two to three per cent. of phthysical cases were followed by this form of insanity; but in looking over the McLean Asylum Reports eleven years ago, I found only five cases out of 5,116 attributed to phthisis, and in asylum reports generally, I find very few cases tabulated as of phthysical origin.

To aid in determining to what extent the adult brain is affected in phthisis, I have inquired into the history of one hundred and fifty-four cases of pulmonary consumption at the Channing Home, which have come under the care of Drs. Mason, Rotch, V. Y. Bowditch, Lovett and myself with the following results: twenty-five had mental disturbance; three others had convulsions; six others had the unreasonable assurance of improvement characteristic of *spes phthisica*, — the delirium of hope.

MENTAL DISTURBANCE.

CASE I. Miss M., twenty-three years of age, had been a patient at Danvers Asylum, making a good recovery. After her discharge she worked several months in a family, and then (March, 1886) began to cough. She entered the Home, September, 1886, and remained till April, 1887. She was reasonable when she entered, but toward the end of her stay had an attack of melancholia, and would speak to no one. She could not be cared for at the hospital, but was taken to her home, where she recovered from the mental symptoms in the course of nine months. Phthysical disease is steadily progressing, and she is emaciated and much troubled with coughing.

CASE II. Mrs. E., thirty-one years, Swede. Phthisis of one year's standing. On account of delusions left the Home abruptly at the end of nine days. Dr. A. L. Mason saw her afterward, and found it was necessary for protection to remove the children from the mother. Subsequent history unknown.

CASE III. Mrs. L., twenty-eight years, Swede. Advanced phthisis. She has had delusions due to that disease. She turned against her husband and against the Home, and was discharged at her own request at the end of ten weeks. She applied for re-admission but was declined on the ground of insanity.

CASE IV. Miss M., thirty-seven years at time of death. Phthisis of eleven years' standing. She never had a sound mind, and was partly demented during her stay of many years at the Home. The dementia was aggravated by pulmonary disease.

CASE V. Mrs. B., twenty-eight years, entered Home, July 3, 1880, with advanced phthisis of eighteen months' standing. No important change followed admission except that hallucinations of hearing de-

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